# Using System-wide Water Engines and Ecological Models for Habitat Suitability Prediction

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# teps in Corps Planning Process for Ecosystem Restoration Studies

**References**

- **ER 1105-2-100**
  - **Chapter 2, Planning Principles**
  - **Chapter 3, Corps Civil Works Missions**
  - **Appendix E, Civil Works Missions and Evaluation Procedures**

- **IWR Report 95-R-1**
  - **Procedures Manual: Cost Effectiveness & Incremental Cost Analyses**

- **IWR Report 94-PS-2**
  - **Cost Effectiveness Analysis for Environm Planning: Nine EASY Steps**

# Which Effects to Evaluate?

**For ecosystem restoration planning:**

- **Focus on non-monetary, Ecosystem restoration outputs (benef**
  **- Desirable measurable results of ecosystem restoration  measu**
- **Monetary benefits are incidental**
- **Costs have to be calculated**
- **Contributions to Federal objective and study objectives**
- **Other effects important to stakeholders**

# Evaluating Effects: Ecosystem Outputs

- Increases in ecosystem value and productivity, quantity and quali

Examples:
- Habitat suitability
- Habitat units
- Habitat acres restored
  - Desired plant species
  - Spawning area fish
  - Number of breeding birds
- Typical food web restored
- International flyway restored

# Models Can Help in Evaluating Ecosystem Effects

- Ecological functions many shallow water bodies impaired due
  submersed aquatic vegetation (SAV)

Functions SAV:
-Stabilizing sediments
-Enhancing water transparency
-Providing suitable habitat  for epifauna, fish, waterfowl

. System-wide restoration projects planned that contribute to r

. Models explored  for use for ecosystem restoration purposes

# Exploration of the Application of Environmental and Ecological CE-models for Ecosystem Restoration Studies

**Case Study**

- **Colonization of Peoria Lake by SAV after dam construction**

- **Disappearance from lake of SAV 8 years after colonization**

- **Study goal: Exploration of environmental conditions believed to be key in the persistence of submersed aquatic plants**

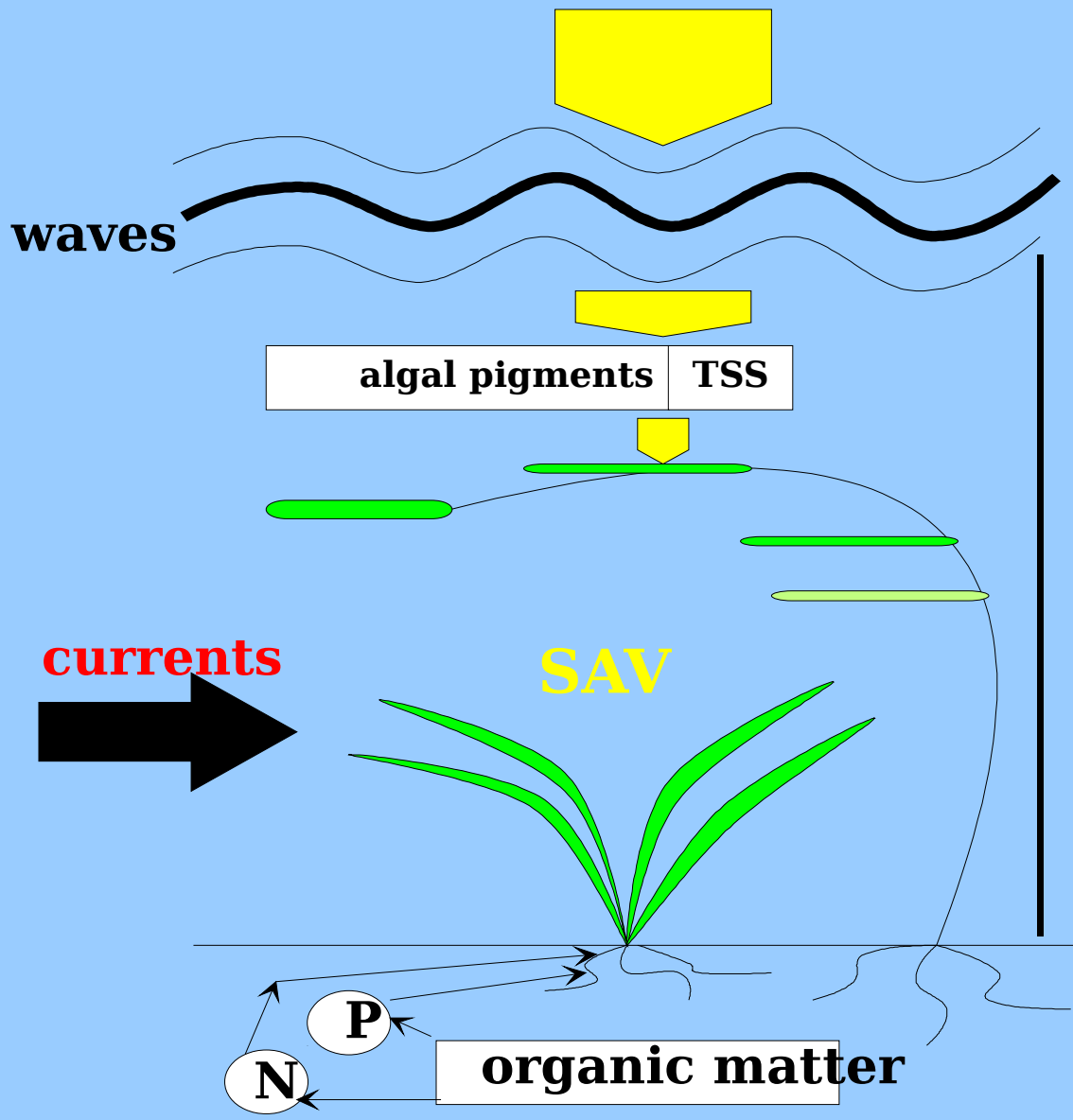
- **Rationale: 'If we know under which environmental conditions SAV persisted in the past, we may be able to get SAV back by re-creating these environmental conditions, assuming that either propagules are still present in the lake, or are highly likely to enter the lake (from nearby sources, or by**

# Approach

- Run 2D hydrodynamic and sediment transport models in sequenc
  using historical and contemporary data for calibration and as inp
- Derive median daily values from modeled data
- Convert TSS concentrations into light extinction coefficients
  median daily values
- Run unique aquatic plant growth models (VALLA, POTAM) using
  and light extinction values as inputs

# Studied interactions between physical and chemical factors governing SAV habitat

## Peoria Lakes Initi




stage

water column
light attenuation

**sedimentation and resuspension**

SAV leaf
light attenuation

biogeochemi
cal
processes

# Properties Peoria Lake, IL

| Property | Value | Date | Reference |
|---|---|---|---|
| Area (ha) | 5,279 | 1998-99 | Beckert p.c. 2000 |
| Res. Time (d) | 1.89 | 1998-99 | James, p.c. 2002 |
| Discharge IR at Marseilles ($m^3 s^{-1}$) | 272,760 | 1939-81 | Demissie & |
| Mean depth (m) | | 1.0 | 1998-99 Beckert, p |
| Mean TSS at POI (mg $L^{-1}$) | | 75 | 2000 James, p.c. 2000 |
| Mean extinction coeff. ($m^{-1}$) | 1.91 | 2000 | James et al., 2002 |
| pH | 7.9-8.5 | 1946-94 | USEPA, STORET; ISWS, unpubl. |
| Mean total alkal. (mg $L^{-1}$) | | 179.2 | 1994 USEPA, STORET |
| Mean nitrate (mg $L^{-1}$) | 3.50 | 1994 | USEPA, STORET |
| Mean ammonium (mg $L^{-1}$) | 0.25 | 1994 | USEPA, STORET |
| Mean o-phosphate (mg $L^{-1}$) | 0.39 | 1994 | USEPA, STORET |

# Historical Changes in Discharge

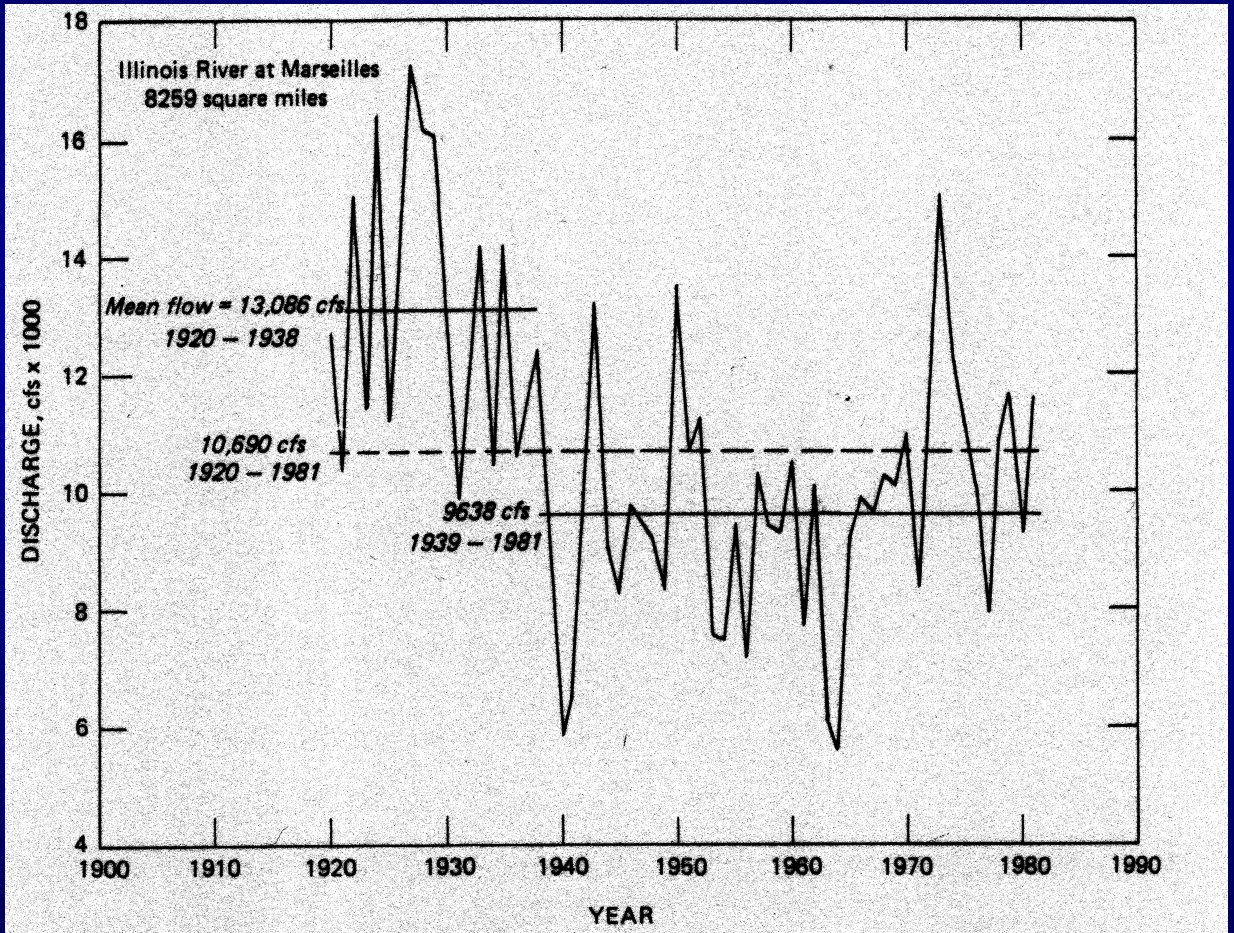



Fig. 2. Influence of Lake Michigan diversion on the Illinois River flow

# Bathymetry Peoria Lake, IL

**1930: before dam construction**
**1946: colonization by SAV**
**1954: disappearance of SAV**
**1998-99: recent times without SAV**
**1998-99: recent times with hypothetical levee**

# Map of Peoria Lake

**Map of Peoria Lake, IL, showing transects (T1-T7) for which simulations of SAV were performed**

# Processing Environmental Model Outputs for Ecological Model Inputs

**Relationship between Total Residue (mg $L^{-1}$) and TSS (mg $L^{-1}$):**

**$Y = 1.938 X - 8.386$,**

**with Y being LN TSS**

**and X being LN Total Residue**

**Relationship between TSS (mg $L^{-1}$) and Light Extinction Coefficie**

**$Y = 0.585 X - 0.614$ for non-channel sites**

**$Y = 0.662 X - 0.888$ for channel sites**

**with Y being LN Extinction coefficient**

**and X being LN TSS**

# Outcomes Combined Model Explorations-1

**Simulated biomass of plants and tubers of *V. americana* in Transect 6 of Peoria Lake in different years and scenarios**

# Outcomes Combined Model Explorations-2

**Simulated biomass of plants and tubers of *P. pectinatus* in Transect 7 of Peoria Lake in different years and scenarios**

# Outcomes Combined Model Explorations-3

- Simulations indicated that *V. americana* occurred before 195 at most transects up to 1 m depth, but would not persist later (without or with levee)

- In contrast, simulations pointed to good persistence conditi in the past for *P. pectinatus*, and marginal conditions at prese at selected transects (T6 and T7) at 0.5-2 m depth;

- Levee construction did not always ameliorate persistence co due to increased current velocity and depth combined with higher transparency.

# Key Takeaway Points

1. Environmental and ecological models combined provided informa
   -habitat suitability,
   -acres
   -more desired plant species persistence
   -less desired plant persistence
   -under environmental conditions anno 2000 without further mana
   measures
   -under environmental conditions anno 2000 after extensive levee

2. The model scenario outcomes predicted a far less fortuitous effec
   levee construction on SAV persistence than intuitively assumed,
   accounting for the combined actions of high current velocity decr
   and increased water transparency increasing biomass. Thus, base
   levee construction would not be a viable, but very costly, plan alte

3. Model scenario explorations provide a cheap tool to develop and
   for ecosystem restoration at various scales.